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Donna J. Veatch

(Name of person mailing paper or fee)

Donna J. Veatch
Signature of person mailing paper or fee)

Apparatus and process for degassing plastic materials, in particular high-molecular polycarbonate solutions

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The invention relates to an apparatus and a process for degassing plastic materials, in particular high-molecular polycarbonate solutions, by means of a double-shaft extruder, which comprises shafts rotating in the same direction and meshing with one another.

As a result of heightened environmental awareness, increasing demands regarding the removal of volatile components from plastic materials are being placed on the plastics processing industry. This applies particularly with regard to the use of plastic materials in the food sector. The volatile components in the extruded plastic material mostly may not exceed 0.2% by weight and are required to be removed in order to improve the product quality, especially the optical properties. This applies particularly to products made from high-molecular polycarbonate solutions containing chlorobenzene and methylene dichloride as volatile components. In the plastics industry, the removal of volatile components from polymers is known as degassing. Various apparatuses are used for degassing, in particular single- and twin-screw extruders.

In the case of degassing by means of single- and twin-screw extruders, a distinction is made between forward and backward degassing as well as single and multiple degassing. With forward degassing the vent opening of the extruder is disposed - in feed direction of the screw - downstream of the intake of the extruder, whereas with backward degassing it is disposed - in feed direction of the screw - upstream of the intake. Degassing extruders are also used, in which both forward and backward degassing are effected. Depending on the desired residual content of volatile components, single-stage or multi-stage degassing is effected. The number of degassing stages cannot however be increased indefinitely because this entails an increase in the manufacturing cost of the product and frequently also a decrease in product quality. The product quality in said case is particularly dependent upon the processing temperature or the temperature rise as well as the retention time in the extruder of the plastic material to be degassed.

The object of the invention is to provide an apparatus and a process of the type described initially, which lead to an economical improvement of product quality, and

indeed in particular enable manufacture of polycarbonate of a particularly high transmittancy.

5. ^{50A}_{B₂} Said object is achieved according to the invention in that the shafts of the extruder are designed with a double lead in the degassing zone and with a triple lead in the pressure build-up zone of the extruder and the extruder has an L:D ratio smaller than/equal to 40, wherein L is the respective screw length and D the respective screw diameter.

^{100A}_{B₁} Conventional degassing extruders achieve, e.g. in the case of high-molecular types of polycarbonate, transmittancy values of 87 to 88. In comparison, with the apparatus according to the invention and the corresponding process it is surprisingly possible to achieve transmittancy values of 88.5 to 89.5 for said types of polycarbonate.

15 Furthermore, the cost of manufacturing the product may be reduced because the extruder of the apparatus according to the invention is of a relatively short design and so the spatial requirement and the cost of the apparatus are correspondingly reduced.

20 Particularly high transmittancy values were achieved with a twin-screw extruder having an L:D ratio in the region of 35 to 40.

To avoid temperature-related quality losses, it is advantageous when the extruder moreover comprises a cooling device defining a cooling zone. In said manner, the product quality may be positively influenced. The shafts of the extruder are preferably designed with a triple lead in the cooling zone.

25 ^{50A}_{B₃} According to another preferred refinement, kneading elements are disposed immediately downstream of the intake opening of the extruder between the feed elements of the shafts. The kneading elements are used to introduce energy and in particular to increase the degassing surface.

30 A high degree of degassing may be achieved particularly when, according to a further refinement, the extruder in feed direction comprises a plurality of degassing zones, to each of which an exhausting device is connected. Very good results were achieved with an extruder which comprises, in feed direction, downstream of the intake opening three degassing zones, wherein there was generated at the vent opening associated with the first degassing zone an absolute pressure in the region of 0.5 to 1.5 bar, at the vent opening associated with the second degassing zone an absolute pressure in the region

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of 0.03 to 1.9 bar, and at the vent opening associated with the third degassing zone an absolute pressure in the region of 0.001 to 0.03 bar.

5 The degassing may moreover be positively influenced by an entraining agent which increases the degassing surface. In the process according to the invention, the entraining agent is admixed preferably in feed direction between a second and third degassing zone. Nitrogen may preferably be used as an entraining agent. The volume rate of flow of the supplied nitrogen should be preferably 2 to 10 Nm³/h, given a shaft rotational speed lower than/equal to 390 rpm.

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Further preferred and advantageous refinements of the invention are indicated in the sub-claims.

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There now follows a detailed description of the invention with reference to a drawing illustrating an embodiment. The single figure shows a diagrammatic longitudinal section of a double-shaft extruder of an apparatus according to the invention.

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The double-shaft extruder comprises a housing, which is composed of eight parts altogether and in which are disposed two shafts (not shown), which rotate in the same direction and mesh with one another. The plastic material to be degassed is supplied to the extruder through the intake opening 2 formed in the first housing part 1. Disposed in feed direction upstream of the intake opening 2 is a vent opening 3 (backward degassing). The drive ends of the shafts are led outwards through a floating ring seal (not shown) at the, in the figure, left side of the first housing part 2.

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sub B₄ >

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Adjoining the first housing part 1 in feed direction is a second housing part 4 of approximately the same length, which has a further vent opening 5. This is followed by a third, longer housing part 6, which is adjoined by a fourth, relatively short housing part 7 followed by a fifth housing part 8, the length of which corresponds to the length of the third housing part 6. The third and fifth housing part 6, 8 have vent openings 9, 10 of equal size, which are more than twice as long as the vent opening 5 of the second housing part 4. The vent openings 5, 9 and 10 are connected to an exhausting device (not shown).

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The fourth housing part 7 is provided with a connection 11, via which an entraining agent, preferably nitrogen, may be admixed.

5 ^{sub B₅} The ~~fifth~~ housing part 8 is followed by three housing parts 12, 13, 14 of approximately equal size, which form a pressure build-up zone, at the end of which the degassed product leaves the extruder. It is evident that a connection opening 15 is formed in the sixth housing part 12. Said connection opening may be used to connect a lateral extruder, by means of which additives may be added to the degassed product.

In the region of said pressure build-up zone, the shafts have a triple-lead profile.

10 ^{sub B₆} ~~Kneading~~ elements are disposed immediately downstream of the intake opening 2 between the feed elements of the shafts. In the region of the housing parts 1, 4, 6, 7 and 8 the shafts are designed with a double lead. The double-lead and triple-lead shaft profiles in said case have differing angles of lead and/or directions of lead.

15 The apparatus according to the invention is operated in such a way that there is at the first vent opening 3 an absolute pressure of 1 to 2 bar, at the second vent opening 5 an absolute pressure of 2.5 to 1.5 bar, at the third vent opening 9 an absolute pressure of 0.03 to 0.9 bar and at the fourth vent opening 10 an absolute pressure of 0.001 to 0.03 bar.

20 The double-shaft extruder preferably operates at a rotational speed which is lower than/equal to 390 rpm. The volume rate of flow of the supplied nitrogen is preferably 2 to 10 Nm³/h.

25 ^{sub B₇} To avoid temperature-related quality losses, the extruder is provided with a cooling device (not shown). The cooling device is formed preferably in the region of the housing parts 12, 13, 14.

30 It has been shown that with an apparatus configured in said manner it is possible to manufacture a polycarbonate of a particularly high transmittancy, namely transmittancy values of 88.5 to 89.5 in the case of high-molecular (valency number 1.33) types of polycarbonate.